Ajax CNC

CNC10

Installation Manual

Rev. 050301

© 2005 AjaxCNC Milesburg, PA 16853

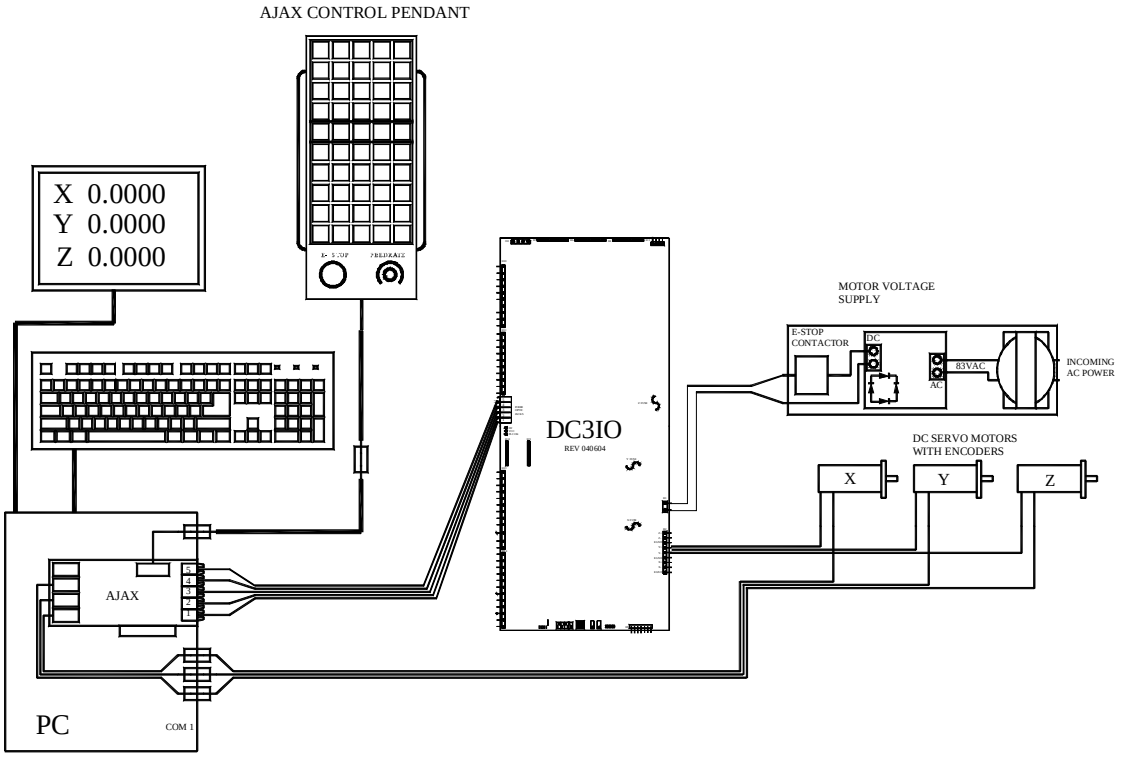
Table of Contents

1. Introduction
    - 1.1 System Overview
    - 1.2 AJAX Components
    - 1.3 Installer Supplied Components
    - 1.4 Optional Supplied Components
2. Motion Control Card (CPU10)
3. Control Pendant
4. Software
5. System Schematic
6. Electrical Panel Layout
7. Servo Drive (DC3IO)
8. Motor and Encoder Cables
    - 8.1 Motor and Encoder Cable Installation
    - 8.2 Encoder Check
9. E-Stop Circuit
10. Limit Switches
11. Motor Power
    - 11.1 Troubleshooting
12. Lube
13. Coolant Control
14. Spindle Speed
15. Other Outputs
16. Digitizing/Probe

1 Introduction

This manual describes how to install the Ajax CNC (Computer Numerical Control) system. It is strongly recommended that you follow each step in order without skipping steps. The PC based Ajax CNC system provides 3 to 4-axis closed loop servo interpolated motion, controlled by industry standard G-codes. The system is intended for CNC control of milling machines, routers, lathes, flame, plasma, laser and water jet cutters and other specialized applications. The Ajax CNC system is intended for use by competent installers, retrofitters and machine tool builders who want to do their own installation. This manual is not intended for casual end users. A separate operators manual is available for end users on CD ROM.

Figure 1: AJAX System Overview



1.1 System Overview

The Ajax CNC system is based on two main printed circuit boards and an optional control pendant. Figure 1 shows (1) the CPU10 motion control card and (2) the DC3IO servo driver board, (3) the jog panel/pendant. Also notice the DC brush servo motors and the DC motor voltage unregulated supply. Servo motors and other CNC components are available from www.AjaxCNC.com.

- CPU10 - Motion Control Card
- DC3IO - Three axis servo amplifier with PLC I/O
- Control Pendant - Provides control keys for the operator

1.2 AJAX Components

Qty.	Part No.	Description
1	10464	CPU10 motion control card
1	10250	Encoder/Jog Panel Bracket w/ribbon cables
1	10483	DC3IO Servo Drive
6	10234	5' fiber optic cables
1	10274	Jog Pendant
1	10237	Intermediate Jog Pendant Cable
1	--	Ajax CNC CD-containing manuals
1	--	Linux Source CD

1.3 Installer Supplied Components

Your PC should have the following minimum specifications:

A. Pentium 400MHZ or better

B. 128MB Hard Drive or better (provided)

C. 128MB Memory or better

D. Linux Operating Software (provided)

E. 1 open PCI slot

Electrical Enclosure

24" x 36" x 12" minimum recommended

1.4 Optional Installer or AJAX supplied components

Axis motors

a) 17in-lb, 29in-lb, and 40in-lb DC brush motors with encoders are available from AjaxCNC.com.

b) Pre-wired motor cables are available from AjaxCNC.com.

DC Power Supply consisting of the following:

a) Primary transformer with secondary 83VAC output provides 120VDC after rectification.

b) Capacitor, 12,000uf minimum, 160VDC

c) Fuse Holders & 15A fuses

Misc. Electrical components	Suggested Source
a) Rotary electrical disconnect	AjaxCNC.com
b) Fuse Holders	AjaxCNC.com
c) Quencharc	AjaxCNC.com
d) Terminal strips	AjaxCNC.com
e) E-Stop contactor, E stop switch	AjaxCNC.com
f) Spindle inverter	Automationdirect.com
g) E-Stop contactor	AjaxCNC.com
h Coolant contactors	AjaxCNC.com
i) Spindle reversing contactors	AjaxCNC.com
j) Limit Switches, normally closed type	Automationdirect.com

2 CPU10 Motion Control Card

The CPU10 motion control card is an PCI PC interface card. The CPU10 card accepts encoder inputs from the servo motors and uses a DSP to perform the servo PID control algorithm. The CPU10 card outputs torque commands serially down onto two fibers (DATA and SYNC) to the DC3IO board. The CPU10 card also passes PLC I/O information to the DC3IO card through the #1, #2, and #3 fibers.

2.1

Plug the CPU10 motion control card into a PCI slot in your PC motherboard. Notice the AjaxCNC CPU10 requires only one PCI slot.

Figure 2

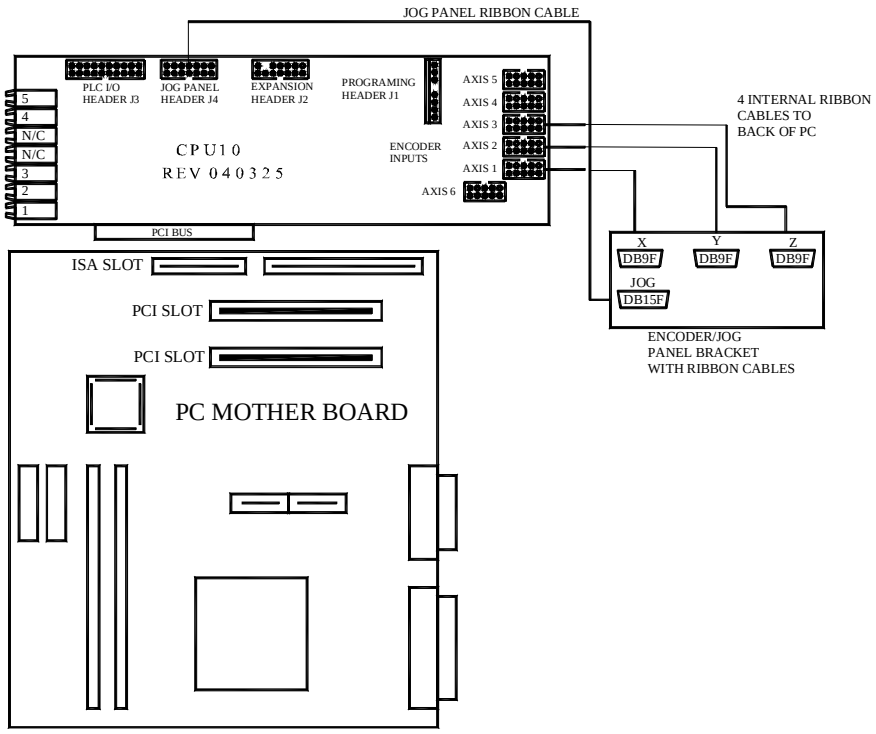
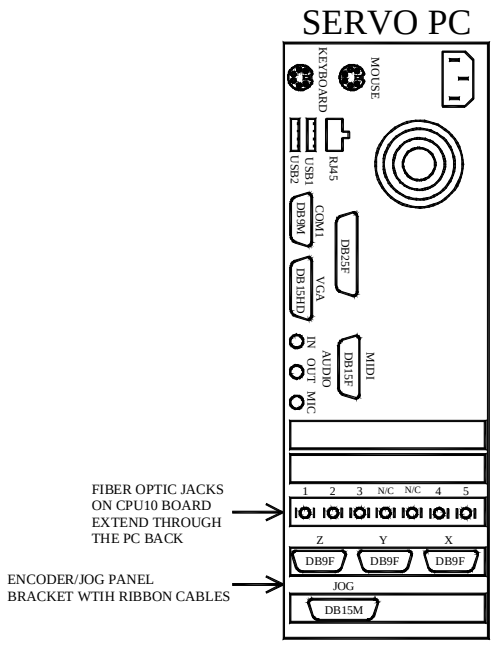


Figure 2.1: CPU10 Fiber Optic Connections



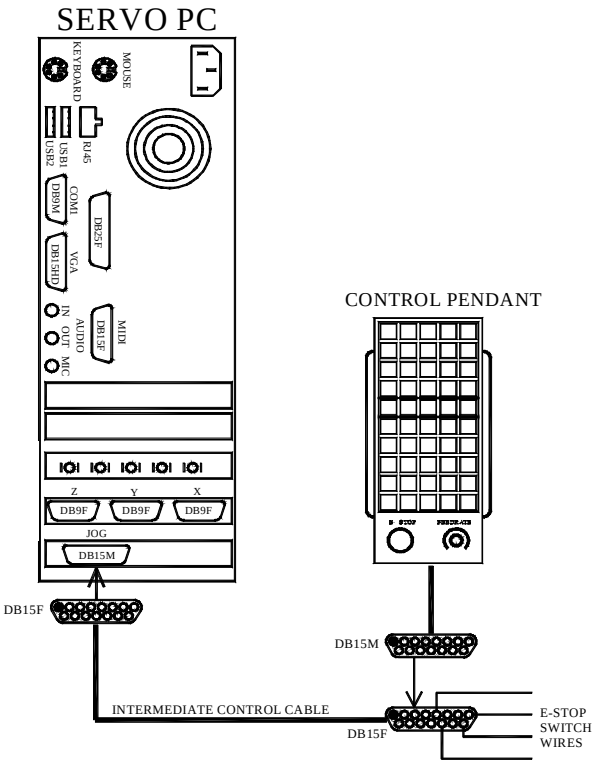
2.2 Encoder/Pendant Bracket Installation

Install the backpanel connector bracket into the PC backpanel. Connect the internal encoder ribbon cables to their respective axes on the CPU10 before plugging into the PCI slot.

3 Control Pendant Installation

Install the Control Pendant Intermediate Cable in your electrical cabinet and plug the end **WITHOUT** the red and blue wires into the DB15 pendant connector on the back of your PC.

Figure 4 - Control Pendant Cable Hookup



All key press data and optional MPG data is sent serially to the Control Panel cable, plus an LED indicator status is sent back.

See the E-Stop section and the Schematic for E-Stop circuit hookup (Red and Blue wires from the pendant E-Stop button).

4 Software

Ajax CNC motion control software (CNC10) is a Linux based program.

4.1 Software/Hard Drive Installation Instructions

The AjaxCNC software comes preinstalled on a 128MB solid state flash drive. With no moving parts, this type of drive is far more stable in a machining envirinment.

1.) Install the IDE Flash drive reader. Install this component in place of the existing master hard drive. If this is a new PC, simply install the Flash card reader in the first IDE slot on your motherboard using the supplied cable.

2.) With the Flash drive and the CPU10 motion control card installed, boot up the PC to make sure all of your connections are secure.

3.) All of your permanent unlocks have been turned on in your control. Every system is given a 10 day demo code to allow the enduser to try out all of the AjaxCNC features and options. To turn on the control demo mode, follow the instructions below. It is suggested that the demo not be entered until the completion of the installation to take full advantage of the 10 day period.

Note that after software installation, it is normal to have errors displayed in the status window, depending upon whether or not the DC3IO or Control Pendant are connected.

NOTE: If you purchased one of our stocked control systems and ordered the Control Pendant in addition to the base kit, you will need to update your PLC program.

The supplimental CD included with you Ajax CNC system contains all of our standard PLC programs. The read-me file in the PLC Programs folder clearly explains what each PLC program is for. Choose the correct PLC program for your application and follow these steps to update the control:

1.) Unzip and extract the PLC zip file to a blank floppy disk.

2.) Insert the floppy into the control computer.

3.) From the main screen press <F7> Utlity, <F2> Update.

The files will automatically update the control. You will need to reboot when you are finished. This is the same procedure used for all control updates.

5 Electrical Panel System Schematic

A “D” size AJAX system schematic is provided with every kit. The schematic can also be found as an AutoCAD.dwg file on the Ajax CD that came with your kit along with several other smaller schematics. They are listed below for your reference. Also provided on the Ajax CD is a program for viewing CAD files.

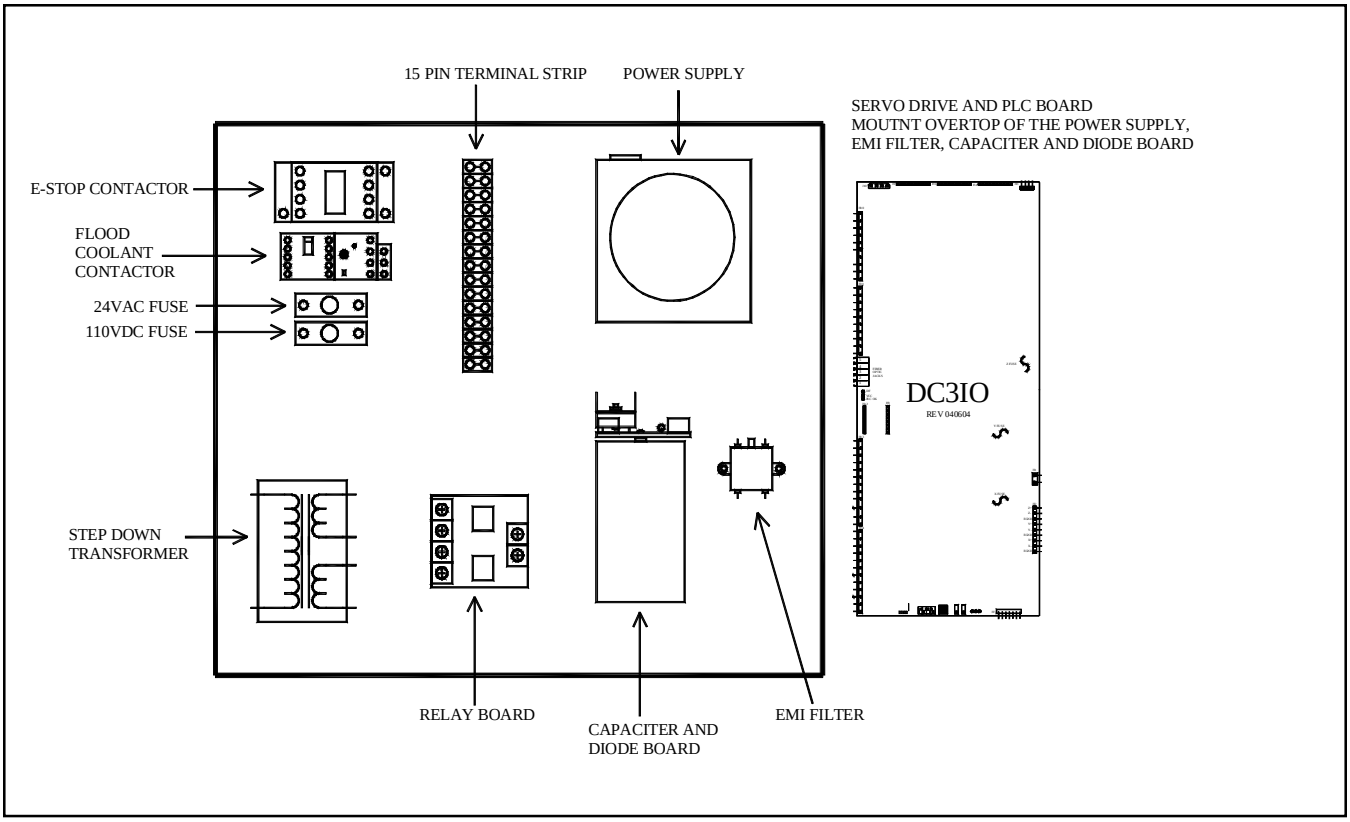
Included 8 1/2” X 11” Detailed Schematics:

- Inverter Power and Control
- Coolant Control
- Lube Pump
- Inputs and Outputs
- 110VDC Power Supply
- Indexer
- E-Stop circuit
- Brake
- Control Pendant
- Probe/Digitizing Connection

6 Electrical Panel Layout

The illustration below is how we suggest you lay out your electrical panel. This is only a suggestion, however, and you may need to modify this arrangement to better suit your needs.

Figure 6 - Panel Layout (Suggested)



7 Servo Motor Drive: DC3IO

The DC3IO combines a three axis brushed DC servo motor drive along with sufficient I/O to control lathes, mills or routers. For example, with suitable 29in-lb motors the DC3IO can easily drive a Bridgeport Boss Series I milling machine.

As the name implies, DC3IO stands for 3 axis SERVO drive with integrated PLC I/O.

Specifications of the DC3IO Board:

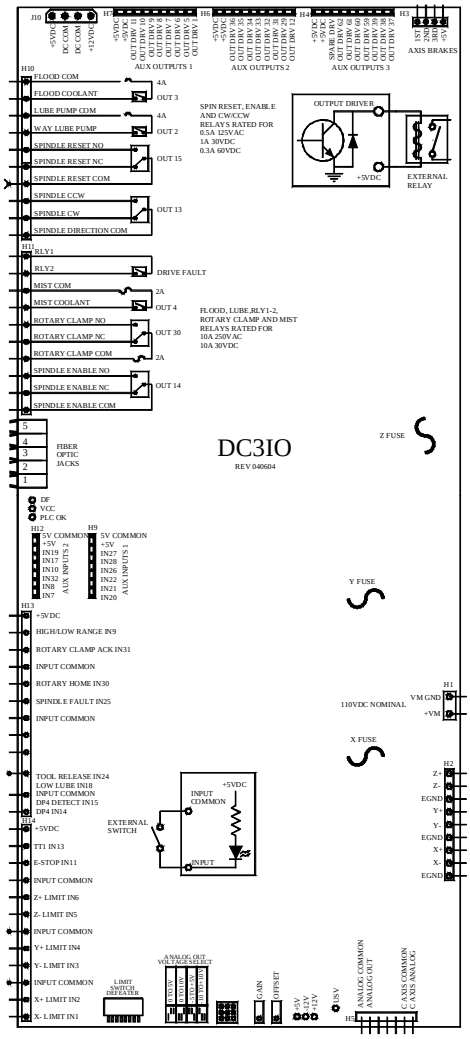
- 3 DC brush servo motor outputs up to 15Amp at 120VDC
- 35 General purpose outputs (recommended for, but not dedicated to coolant, brake and auxiliary controls)
- 4 Dedicated outputs: lube, spindle enable, CW and CCW
- 1 Spindle speed control, 12 bit DAC
- 1 E-Stop series connection relay contacts
- 6 Dedicated limit switch inputs
- 24 General purpose inputs
- 2 Dedicated inputs, E-Stop + Drivefault

7.1 Installing the DC3IO board on your electrical panel

Warning: Do not hookup or apply motor voltage at this stage.

Motor voltage will be applied in Chapter 11. All systems must be checked out first. Refer to the Ajax CNC detailed schematic.

Check the connections from the DC3IO to the power supply. The DC3IO is supplied with +12 and +5VDC from the power supply via the J10. Ensure that J10 is connected to the power supply. These DC voltages are used to power the logic of the servo drive and the logic of the PLC I/O section.



8.1 Motors and Encoders

Ajax CNC motors are DC brush servo motors and have 2000 line/8000 count per revolution encoders. Differential line signalling is used for noise immunity. Encoder cables should use shielded wire with twisted pair signal lines for noise immunity reasons (See Figure 8.1). Reliable operation at distances up to 50' are possible. Motors may be “hard wired” without the use of MS connectors for cost reduction reasons. Fully wired servo motors with cables may be ordered from AjaxCNC.

8.2 Installation

Wire your motor cables to H2 on the DC3IO board. The DC3IO board has labels next to each terminal on H2 to aid in the wiring. The earth ground (EGND) terminals are used for shield connections.

Plug the X, Y, and Z axis encoder cables into the X, Y, and Z encoder sockets on the PC’s back panel (Once again pay close attention to matching up each axis with its corresponding location). Wildly erratic motor motion will result if encoder and motor hookups are not correct. Refer to the Ajax CNC schematic.

8.3 Encoder Check

Power up the PC, but do not apply power to the drive (DC3IO). With the PC powered up and without any power to the drive and motors, you can test the encoder feedback. Go to the PID menu to verify encoder feedback. From the main CNC10 screen, press <F1> Setup, <F3> Config, <enter password (137)>, <F4> PID . Turn each axis motor shaft slowly and watch the absolute position (Abs Pos) column for smooth counting. Turning the motor shaft in the other direction should count down. Ignore “full power w/o motion” or “Position Error” messages in the message box. Ensure that the correct readout changes for each axis motor.

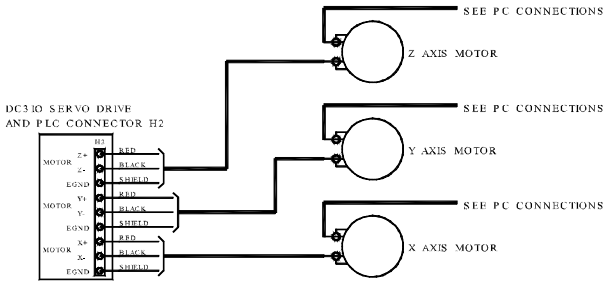
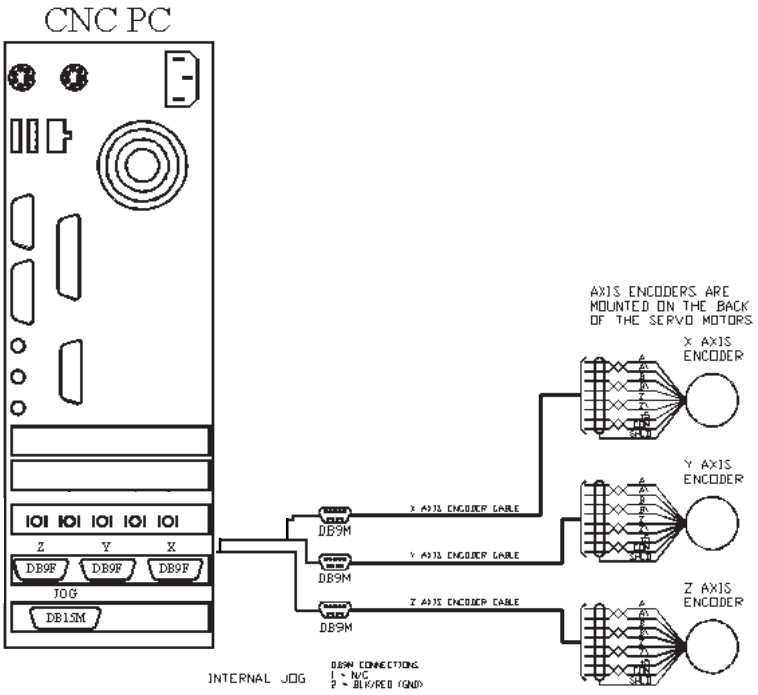


Figure 8.1 - Motor Encoder Diagram



9 ESTOP Circuit

An effective emergency stop (E-Stop) circuit is essential to any machine tool and is required by insurance carriers. The E-Stop circuit allows the operator to push an E-Stop button and stop all axis motion and the spindle motor. The E-Stop circuit shown on the Ajax CNC schematic is based on a 24v AC voltage which is required to power the E-Stop contactor coil. As long as the E-Stop circuit is not broken, the system will operate. The 24VAC coil voltage is "routed" through the DC3IO relay contacts labeled "Drive Fault". From there the E-Stop coil voltage must pass through the E-Stop button and then through the inverter fault contacts before returning to the 24VAC terminal. E-Stop may be tripped by pushing the E-Stop button, by a Servo Drive fault, or by an Inverter fault.

9.1 Blue Loop Installation

The blue loop consists of two blue wires on the Intermediate Control Pendant cable. These two wires must be connected to E-Stop and Common on H14.

9.2 Red Loop Installation

The Red Loop is the 24v AC circuit that is required to power the E-Stop contactor coil. To complete the circuit connect the first red wire on the Intermediate Control Pendant cable to the "Drive Fault" (RLY2) pin on H11 on the DC3IO. The other "Drive Fault" (RLY1) pin on H11 must be connected to terminal 1 on the 24 VAC supply. The second red wire on the Intermediate Control Pendant cable must be connected in series to A2 on the E-Stop contactor. Connect A1 on the E-Stop contactor to terminal 2 on the 24 VAC supply.

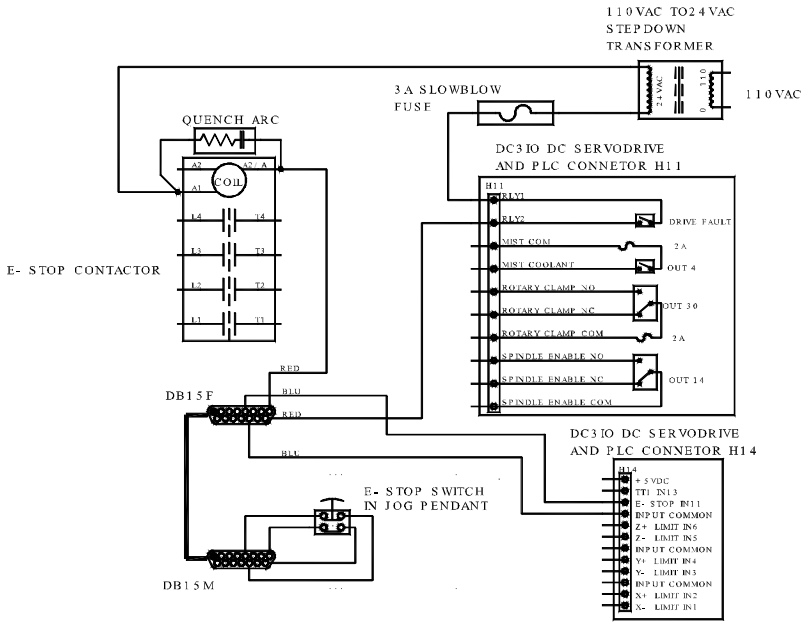


Figure 9.1 - E-Stop Circuit with Pendant

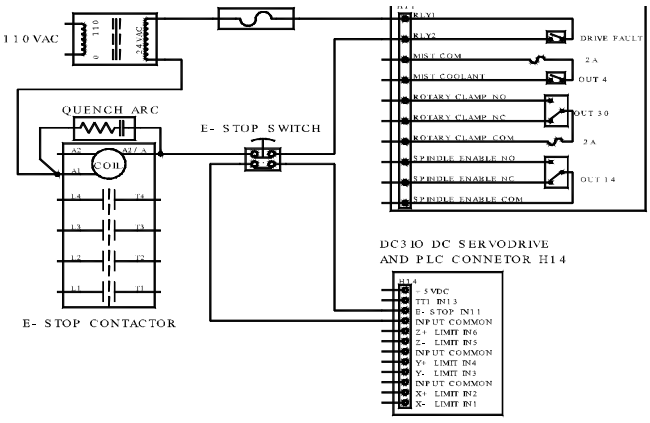


Figure 9.1 - E-Stop Circuit without Pendant

10 Limit Switches

Limit switches are required to be normally closed (NC) switches, which are attached to header H14 of the DC3IO board. Each limit switch input is actually pulling down on an optoisolator input on the DC3IO board (Figure 10.1). When a limit is reached the Limit switch will trip the optoisolator circuit. Typical Limit switches are used for both overtravel protection and HOMING the machine at powerup.

A typical Limit switch hookup is shown in the diagram below (Figure 10.2). Connect each Limit switch on the X, Y, and Z axis to it's respective pin on H14 on the DC3IO, as shown in the schematic.

The AJAX system can be operated without limit switches. To defeat the need for limit switches, flip up (on) all the paddles on the LIMIT DIP Switches and place a jumper between each limit input and their respective common. Also, you will need to set the limit inputs to "0" in the motor setup menu.

This is very useful for initial testing, but always remember to push all the dip switches down when you want to install your limit switches (See TB061).

The AJAX system also supports software travel limits and Machine Home to Mark (See Chapter 3 of the Ajax CNC operator's manual).

Figure 10.1 - Typical Optoisolated Input

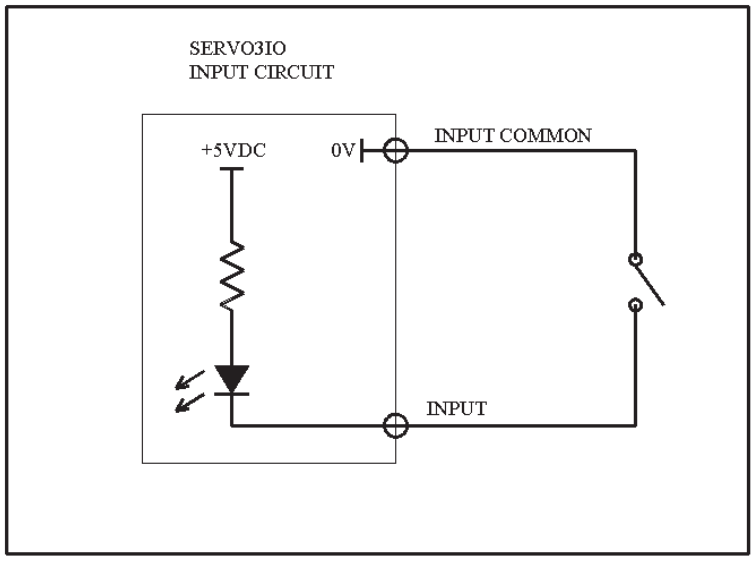
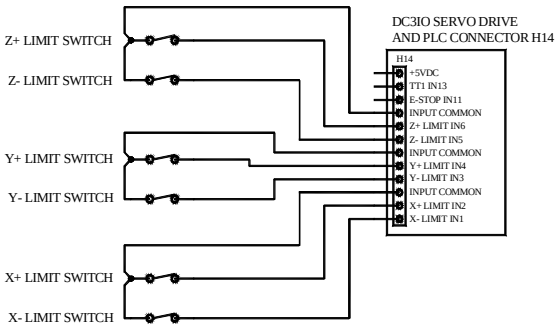


Figure 10.2 - Limits Input



11 Motor Power

Warning: Only a qualified electrical / electronics person should perform these steps.

Install your main power connections. Do Not Turn on the power yet, just make and check all connections.

Check all Motor Supply (Vm) related connections on the Ajax CNC schematic.

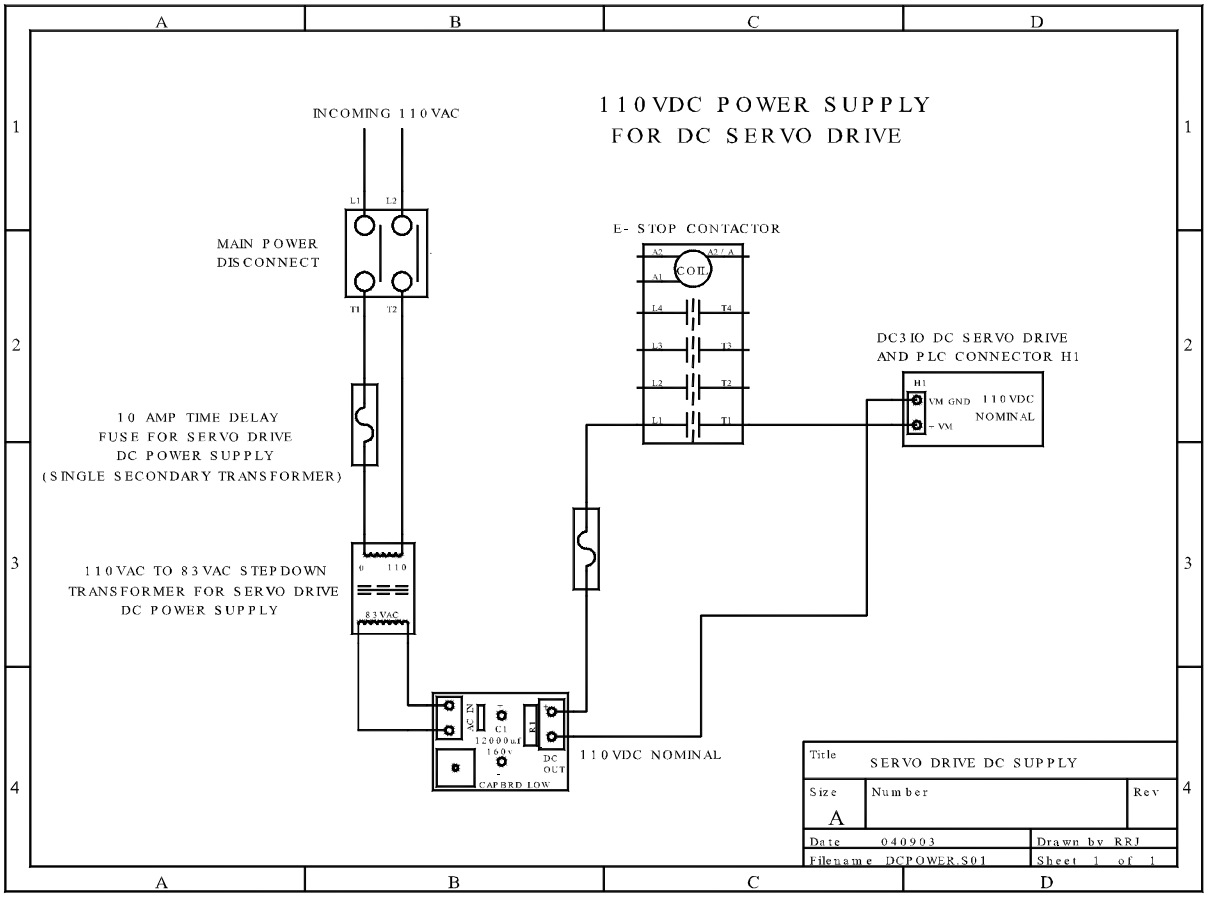
1. Main Disconnect
2. Step down transformer for Vm (Motor Supply Voltage)
3. Rectifier Bridge (Vm)
4. Capacitor (Vm) (double check bridge vs capacitor polarity)
5. Inrush limiter
6. Bleed down resistor (6.8k 5W)
7. Vm fuse 15A
8. Connection to E-Stop Contractor
9. PC and DC3IO's 110VAC power supply connection
10. Ajax Power bridge.

With the E-Stop pushed in, apply the AC voltage to the input of the motor power supply. Check the motor voltage (Vm) from the supply at the capacitor terminals. There should be approximately 120VDC across the terminals. Notice the DC, this is for servo motor power and is not to be confused with 120VAC input voltage. If you intend to use lower voltage motors such as Pittman 24VDC motors, then a suitable transformer must replace the 83 VAC secondary winding transformer referred to in the Ajax CNC examples. Do not attempt to apply voltages above the servo motor's maximum rating of 140VDC.

If you have installed and checked everything up to this point you can now check axis motion operation without installing the other optional subsystems such as spindle, coolant, and lube controls. Connect the DATA and SYNC fiber cables between the DC3IO and CPU10 cards. See sections 5 and 6 if you have trouble locating the DATA and SYNC connectors on the cards. Release the E-Stop button and the E-Stop contactor should make a "clunk" sound as it turns on. If you're using an inverter, you will have to power it up and clear any fault conditions to get the E-Stop contactor to close.

Power should now be applied to the drive's Vm and GND connections. Jog each axis in both directions and verify smooth motion from the motors, see section 11.1 if movement problems are encountered. If the motors are not mounted on the machine yet, mount them before continuing to section 11.2.

Figure 11 - DC Servo Motor Power Circuit



11.1 Servo Motor and Encoder Troubleshooting

CNC7 Error Message	Motor Symptoms	Possible Problems	Solutions
? Axis position error	Makes a quick jump when jog button is pressed	Motor wires may be reversed or A and B encoder channels have been swapped	Reverse motor lead connection
? axis full power w/o motion	Moves full speed until error condition is detected	Encoder is not plugged in or encoder is bad, drive is not powered up	Check connections for each axis -- an encoder is plugged into the axis but may not be from the correct motor, replace encoder and check drive and E-Stop connections.
? axis home to close to switch	Will not home correctly	Index pulse is missing	Check Z and /Z channel wiring, replace encoder if necessary.
? axis runaway: check motor wiring	No Motion condition is detected -- runaway is not on axis that was moving	Encoder cables for two axes are swapped	Plug the cables into the correct locations and restart the control PC (this error latches and requires a cold restart)
? axis runaway: check motor wiring	No Motion	Encoder cabling is faulty or encoder was plugged in with power on	Check cables, restart control PC (this error latches and requires a cold restart)
? axis encoder connection is bad	No Motion	Encoder cable is not plugged encoder cable is faulty	Check encoder connections
	Strange sounds or rough motion	PID parameters not correct, encoder problem, or motor problem	Run autotune, swap encoder with a known good unit to locate problem source.

Note: ? will be either X, Y or Z

11 Servo Motor Power

The following steps should be taken to ensure accurate motion control after motors have been mounted on the machine:

(1) Check the encoder count settings in the machine setup screen (Press <F1>, <F3>, <enter password>, <F2> from the main screen). The encoder counts should be 8000 for Ajax CNC supplied motors.

(2) Make sure each jog key moves its axis in the desired direction. See the “Conventions” section in Chapter 1 of the Ajax CNC user’s manual for the recommended axis setup. If an axis is moving in the opposite direction, change the direction reversal settings in the machine setup screen.

(3) Setup the motor revolutions per inch for each axis. Refer to tech bulletin TB036 for assistance.

(4) Autotune should be run to set up the motor PID parameters. This can be reached by pressing <F1> Setup, <F3> Config, <enter password>, <F4> PID, <F5> Tune from the main CNC10 screen. On-screen instructions will tell you how to start the tuning process. For more information on autotune results refer to TB045 and TB004.

(5) Run dragplot. This feature will help reveal mechanical problems that may effect performance. TB047 details running dragplot.

Technical bulletins can be found on the supplied CD or on the User Support section of the AjaxCNC website.

12 Automatic Lubrication Pump

The lube pump should be connected to H10 as shown in the diagram below (Figure 12). The 110 VAC supply for the lube pump should also be connected to H10 as shown in the diagram and on the schematic.

After the lube pump is installed, you must connect the Low Lube warning circuit. Connect the pump alarm common to Common on H13 on the DC3IO. Then connect the lube pump alarm (NC) to the "Low Lube" input on H13 on the DC3IO.

If you are not using a lube pump, you will need to place a jumper between the Common on H13 and "Low Lube" on H13.

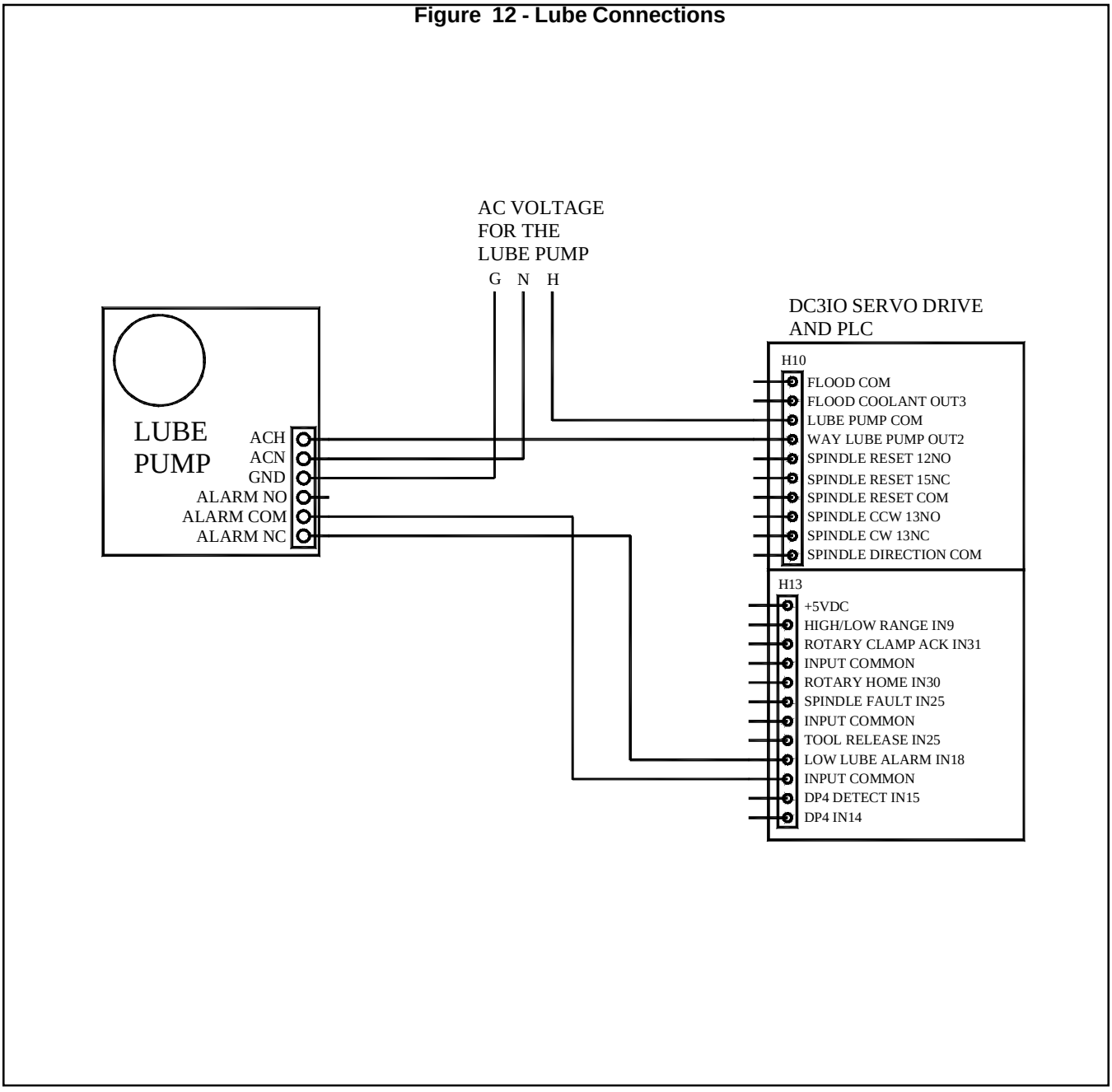
13 Coolant Control

The DC3IO is capable of controlling a coolant pump using a coolant pump contactor.

13.1 Coolant Pump Contactor

Ajax CNC coolant pump contactors requires a 24 VAC supply to power the contactor coils. You must connect the coolant contactor coil to the Flood and Flood Common on H10. Supply power as shown on the schematic.

Figure 12 - Lube Connections



14 Spindle Control

The spindle control section of the DC3IO provides an analog output that is factory preset for 0-10v DC output to an inverter in 0.004v increments. The internal Digital to Analog Converter (DAC) converts a 12 bit value for high resolution spindle speed control.

14.1 Spindle Motor

The Ajax CNC system is capable of driving a spindle motor using either an Inverter (recommended), or by using Reversing Contactors.

14.2 Spindle Motor with Inverter

A typical Inverter wiring diagram is shown on the schematic (Figure 14.1). Exact wiring will vary from one Inverter to the next, so refer to your Inverter manual for specific wiring instructions.

In the example shown on the schematic the supply voltage is routed through the Inverter and E-Stop contactor before going to the spindle motor. The Spin Forward, Spin Reverse, Inverter Common, 0-10 VDC Input, and the 0-10 VDC Common pins on the Inverter are all connected to H5 as shown on the schematic (Figure 14.1). Again, the schematic shows only a typical Inverter Installation, for details on connecting your Inverter please refer to your Inverter Manual.

14.3 Spindle Motor with Reversing Contactors

On the Ajax CNC schematic you see a typical circuit diagram for wiring the spindle motor with reversing contactors. For the DC3IO to be able to control spindle direction, Pins CW and CCW on H5 must be connected to the Reversing Contactor coils as shown on the schematic.

Terminal 2 on the 24 VAC supply must be connected to the Spin ENCOM pin on H5 as in the schematic. Terminal 1 on the 24 VAC supply must then be connected to one side of the Reversing contactor coils as shown. The other side of the Contactor coils must be wired as shown to allow the DC3IO to control the Reversing Contactors.

It is essential that the 220 VAC supply for the reversing Contactor and the Spindle Motor be connected to the output side of the E-Stop Contactor and NOT the 220 VAC input side of the E-Stop Contactor so that the E-Stop circuit is capable of controlling the power to the Spindle Motor and Spindle Speed Control with inverter.

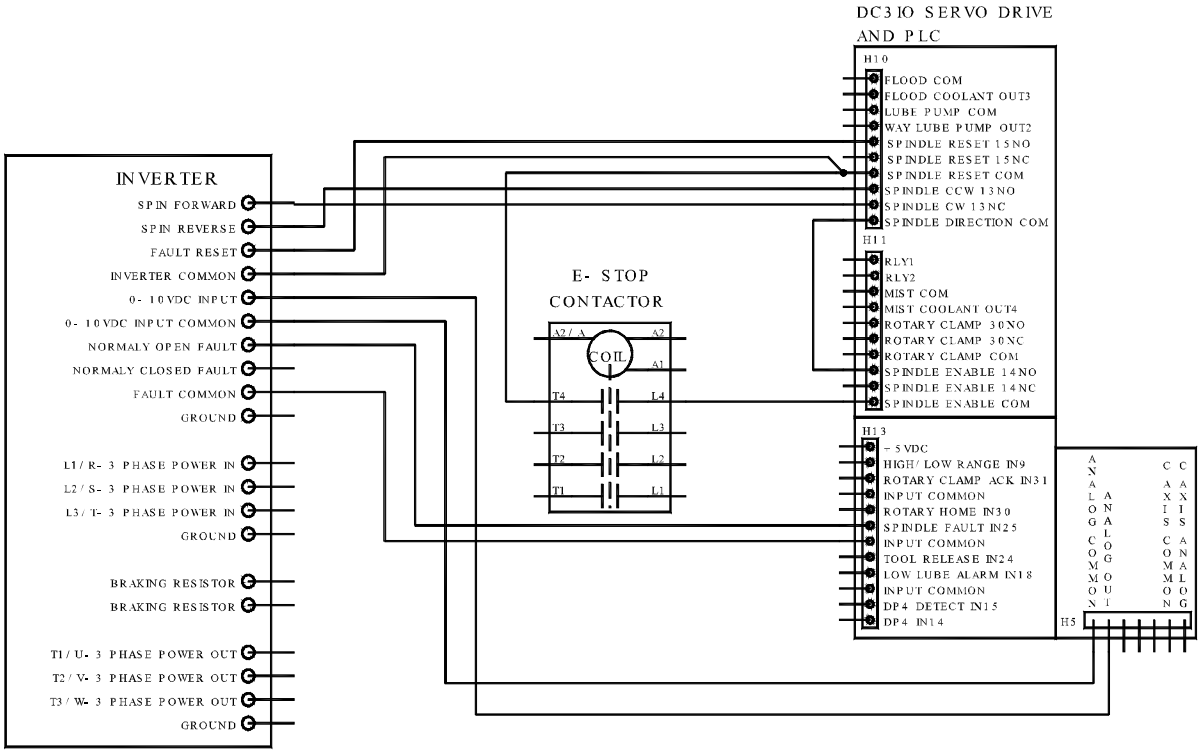
14.5 Spindle Speed Setup

1) Change maximum spindle speed to match your spindle and inverter.
   a) From the CNC10 main screen press <F1> Setup, <F3> Config, <F1> Control.
   b) Change the value for maximum spindle speed so that it's the same as the specs for the inverter and spindle motor.
   c) Press <F10> to save this screen and exit.

14.6 Troubleshooting Spindle Output

1) Parameters
   a) Press <F1> Setup, <F3> Config, <F3> Param to enter the parameters screen.
   b) Check parameter 31. This should be set to -1.
   c) Edit parameter 32. Enter the baud rate of 19200.
   d) Edit parameter 33. Enter your spindle gear ratio.
   e) Press <F10> to save and exit.
   f) Press <ESC> until CNC10 main screen appears.
2) Make sure that the spindle is not inhibited by the PLC program.
   a) The E-Stop must be released to start the spindle.
   b) The digitizing probe must be unplugged.

Figure 14.1 - Spindle Inverter Control Diagram



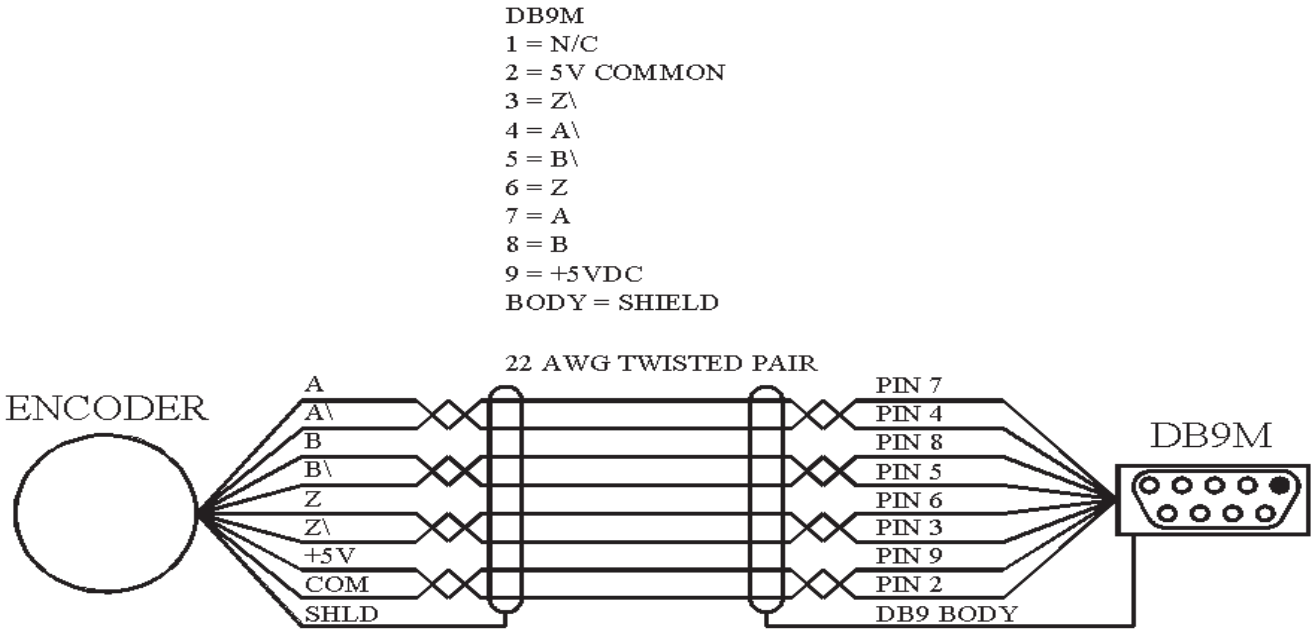
14.7 Spindle Inverter Fault Input

Refer to your Ajax CNC schematic.

14.8 Spindle Hi-Low Range

Refer to your Ajax CNC schematic and Hi-Low schematic found on the supplimental CD for wiring details if your machine is equipped with a Hi-Low gear range.

Figure 14.3- Spindle Encoder Cable Hookup Diagram



14.9 Spindle Encoder Settings

The Ajax CNC supplied encoder is a 2000 line encoder which yields 8000 counts per revolution of the spindle. Spindle encoders have to be connected directly to the spindle itself at a 1:1 ratio. Other line encoders may be used. 500, 1000, 1024 etc. and the control parameter 34 must be adjusted accordingly.

The encoder cable used should be a shielded cable. Ajax CNC spindle encoder cable spec: Minimum 22 awg, 4 twisted pair. Attach shield wire to DB9 case, typically soldered, and other end to encoder case/cover that is grounded to the machine. Listed are some configuration parameters related to the spindle encoder. Parameter # Description:

•P34: Spindle Encoder Counts Settings:
Must be set to the number of counts for the Spindle Encoder. 1000 line=4000 counts, 2000 line=8000 counts etc..

•P35: Spindle Encoder Input, selects which encoder port the spindle encoder is hooked to. Settings:
0 - Encoder port 1 1 - Encoder port 2
2 - Encoder port 3 3 - Encoder port 4
4 - Encoder port 5

The 5th axis encoder input is primarily used for spindle encoder input. Set P35=4 when connecting encoder cable to the 5th axis encoder input as per the Ajax CNC drawing.

•P78: Spindle speed display. Settings:
0 - Displays programmed spindle speed
1 - Displays actual spindle speed, from the spindle encoder.

•P31: Spindle output port. Settings:
-1 for all DC3IO systems

•P32: Spindle Output port Baud Rate: Settings:
19200 - Recommended setting

•P36: Rigid Tapping. Settings:
0 - Disable Rigid Tapping 1 - Enable Rigid Tapping
3 - Enable Rigid Tapping and Do Not wait for Index pulse
5 - Same as 1, but enable spindle override during tapping
7 - Same as 3, but enable spindle override during tapping

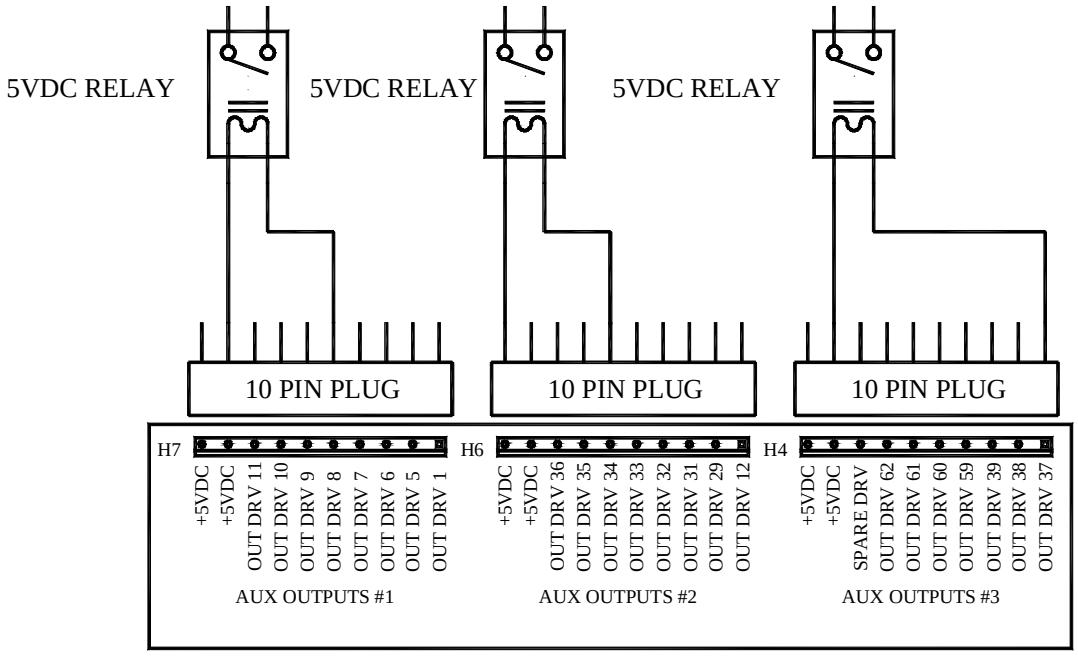
•P37 - Spindle deceleration time. Settings:
Time in seconds for spindle deceleration during rigid tapping. Typical time = 3 seconds. (Note: Your inverter should be set up with a braking resistor and set up to decel faster than this setting.)

•P68 - Minimum Rigid Tapping Spindle speed. Settings:
Typical setting is 500 to 600 rpm for Rigid Tapping.

•P69 - Duration for minimum spindle speed. Settings:
Amount of time to wait when at speed set in P68
Typical setting is 1.5 to 2.

•P82 - # of degrees of rotation before bottom of rigid tap hole that the cycle will spin at slow rpm setting #P68

Figure 15.1 - Relay Output Circuit



DC3IO SERVO DRIVE AND
PLC CONNECTOR H4, H6 AND H7

Figure 15.2 - Output Driver DC3IO Circuit

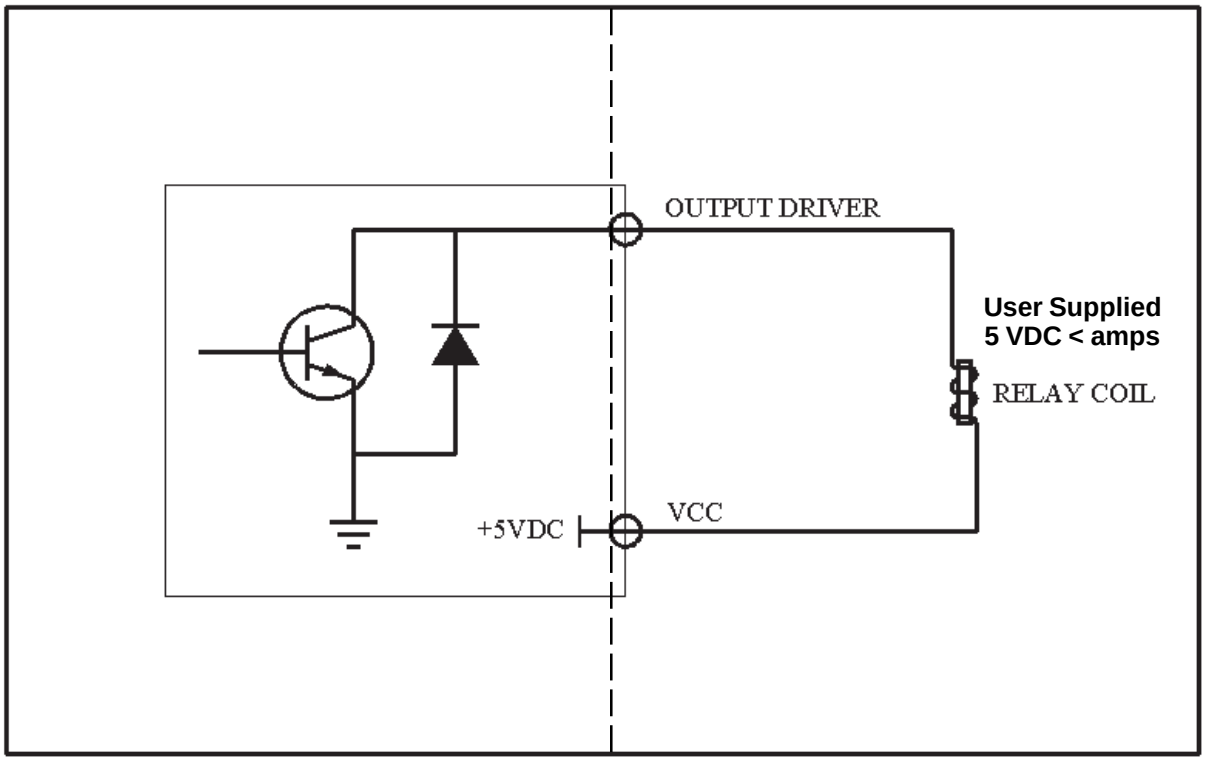
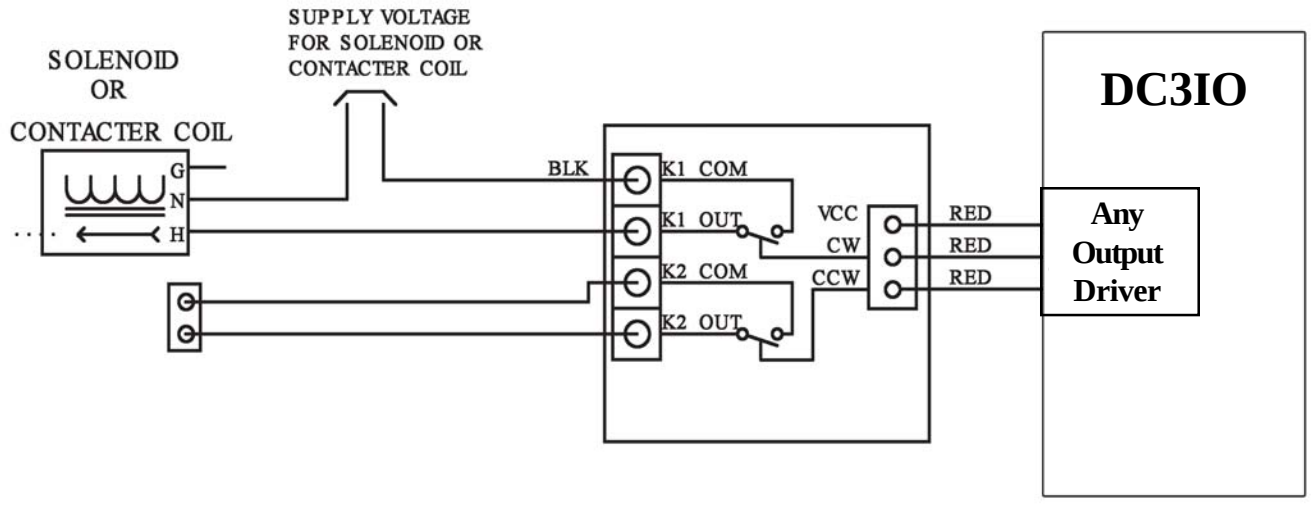


Figure 15.3- Ajax Dual Relay Board



15 Digitizing/Probe Connector

The Digitizing/Probe connector allows the use of an optimal Digitizer/Probe with the Ajax CNC system.

15.1 Digitizing/Probe Installation

The Digitizing/Probe (D/P) connector receives power through the attached Molex connector which must be plugged into the PC power supply on the DC3IO board.

Visit our web site for free downloads of other PLC programs for specific machines. www.ajaxcnc.com.
Keep in mind that just because a standard M code is labeled for a certain function that does not mean you have to use it for that purpose. For example: M8 is used for Coolant. You can use this output to activate a Flood pump OR a mister solenoid. You can use the M8 output to activate a vacuum pump, a clamp, etc….M8 turns it on and M9 turns it off.

Figure 16.1 - Probe / Digitizing Connection